WHAT IS CLAIMED IS:

1. An electron beam apparatus for irradiating a sample with primary electron beams, and detecting secondary electron beams generated from a surface of the sample by the irradiation to evaluate the sample surface, comprising:

an electron gun having a cathode for emitting primary electron beams, said cathode including a plurality of emitters for emitting primary electron beams, said emitters being arranged and spaced apart from each other on a circle centered at an optical axis of a primary electro-optical system;

said emitters being arranged such that when they are projected onto a straight line parallel with a direction in which the primary electron beams are scanned, resulting points on the straight line are spaced at equal intervals.

2. An electron beam apparatus according to Claim 1, wherein each of said emitters comprises a plurality of emitter chips, and is controlled to emit the primary electron beam from one of said emitter chips.

3. An electron beam apparatus according to Claim 1, further comprising an ExB separator, and an objective lens for accelerating secondary electrons emitted from the sample surface, wherein said ExB separator separates said secondary electrons from the primary electro-optical system and directed to a secondary electro-optical system.

4. An electron beam apparatus according to Claim 3, wherein said ExB separator comprises an electrostatic deflector having six or more electrodes, and a troidal or

saddle-shaped deflector arranged outside said electrostatic deflector.

5. An electron beam apparatus according to Claim 1, wherein:

said cathode of said electron gun comprises a plurality of emitters formed on an end surface facing the primary electro-optical system; and

said electron gun further comprises a control electrode having a plurality of apertures.

6. An electron beam apparatus according to Claim 5, wherein:

said plurality of emitters have bottoms formed in the same plane, and said apertures of said control electrode are formed on the same plane; and

said electron gun further comprises a mechanism for performing one of an alignment of relative inclination and spacing of said two planes, and a horizontal alignment of said emitters of said cathode to said apertures of said control electrode.

7. An electron beam apparatus according to Claim 1, wherein each of said emitters is formed near a bottom thereof in the shape of cone.

8. An electron beam apparatus according to Claim 1, wherein said cathode is made of a material included in a group consisting of LaB_6, Ta, and Hf.

9. An electron beam apparatus according to Claim 1, wherein said cathode has said emitters which are formed by cutting a surface of single crystal tantalum having a

surface crystal orientation of <310>.

10. An electron beam apparatus according to Claim 1, wherein said cathode has said emitters which are formed by cutting a surface of single crystal hafnium having a surface crystal orientation of <100>.

11. An electron beam apparatus according to Claim 8 or 9, wherein each of said emitters has a plain surface left at the bottom thereof, said plain surface having a diameter of 50 μm or less, or a width of 10 μm or less in a radial direction of a circle centered at the optical axis and a width of 100 μm or less in a direction orthogonal to the radial direction.

12. An electron beam apparatus according to Claim 1, further comprising:

a speed detector for detecting a moving speed of a stage for carrying the sample thereon; and

a deflection amount correcting device included at least one of the primary and secondary electro-optical systems for correcting the amount of deflection for at least one of the primary electron beams and the secondary electron beams in accordance with the moving speed of the stage from said speed detector.

13. An electron beam apparatus according to Claim 1, further comprising a device for arbitrarily setting energy of electron beams in a range of 0.5 eV or higher.

14. An electron beam apparatus according to Claim 1, further comprising:

an objective lens for accelerating low energy

electrons emitted from the sample surface;

an ExB separator for deflecting electrons passing through said objective lens toward the secondary electro-optical system; and

a plurality of detectors for detecting the intensity of electrons collected through the secondary electro-optical system to convert the intensity to an electric signal,

a spacing between irradiation points of the adjacent primary electron beams is set larger than a sum of an extending diameter of back scattered electrons on the sample and an equivalent blur amount on the sample of the secondary electro-optical system.

15. An electron beam apparatus according to Claim 1, wherein the spacing between the adjacent primary electron beams is adjusted by changing a magnification of an electro-optical system from a generation unit of the primary electron beams to the sample.

16. An electron beam apparatus according to Claim 1, further comprising an objective lens, and an ExB separator positioned between said objective lens and the next lens positioned near said electron gun, wherein said primary electro-optical system and said secondary electro-optical system share a single lens.

17. An electron beam apparatus according to Claim 1, further comprising a mechanism for adjusting a beam dimension or a beam current of the primary electron beams to maximize a contrast or an S/N ratio in a particular

pattern in electric signals of the secondary electron beams detected by said detectors.

18. An electron beam apparatus according to Claim 17, wherein said particular pattern is a regular pattern having a pitch twice a minimum line width of a pattern on the sample under evaluation.

19. An electron beam apparatus according to Claim 1, further comprising:

an irradiation amount detector for detecting the amount of primary electron beams irradiated to the sample surface; and

an irradiation amount controller for controlling to prevent the amount of irradiated primary electron beam per unit area from exceeding a previously set predetermined value based on the amount of irradiation from said irradiation amount detector.

20. An electron beam apparatus according to Claim 19, wherein:

said sample is a semiconductor wafer,

said electron beam apparatus further comprises a device for controlling to evaluate a surface of said semiconductor wafer in units of constant stripe widths while continuously moving said stage, and

said irradiation amount controller is adapted to control every area smaller than the length in a stripe direction of a chip multiplied by a stripe width.

21. An electron beam apparatus according to Claim 1, wherein said sample is a semiconductor wafer, and said

electron beam apparatus further comprises:

an energy filter including an electrode for selectively passing therethrough electrons exceeding particular energy of the secondary electrons emitted from wiring patterns on the semiconductor wafer to direct electrons having energy higher than the particular energy to the secondary electro-optical system; and

determining unit for comparing a fluctuating state of electric signals from said detectors with a fluctuating state of electric signals expected from a connection relationship of regular wiring patterns to determine defects of the wiring patterns, said defects including disconnection and short-circuit.

22. An electron beam apparatus according to Claim 21, further comprising a device for switching a ground voltage and a predetermined voltage for application to a connector connected to an external electrode of the semiconductor wafer.

23. An electron beam apparatus according to Claim 21, wherein said energy filter comprises an axially symmetric electrode, and a power supply for applying said axially symmetric electrode with a voltage lower than a voltage on the semiconductor wafer.

24. An electron beam apparatus according to Claim 1, further comprising:

a discharge phenomenon detector for detecting a discharge between the sample and the objective lens or a leading phenomenon thereof; and

a condition setting unit for setting a condition for preventing a discharge based on an output from said discharge phenomenon detector.

25. An electron beam apparatus according to Claim 24, wherein said discharge phenomenon detector comprises a photo-multiplier tube (PMT) for detecting light generated upon a discharge or a leading phenomenon, or a sample current meter for detecting an abnormal current generated in the sample upon a discharge or a leading phenomenon.

26. An electron beam apparatus according to Claim 24, wherein said condition setting unit is adapted to adjust a voltage of a decelerating electric field between the sample and the objective lens or the amount of primary electron beams to prevent a discharge.

27. An electron beam apparatus according to Claim 24, wherein said discharge phenomenon detector is adapted to detect a discharge or a leading phenomenon thereof in a partial region of the sample which is not used as a product.

28. An electron beam apparatus according to Claim 1, further comprising:

a plurality of detectors each for detecting the intensity of electrons collected through the secondary electro-optical system to convert the intensity to an electric signal; and

an image processing unit for processing the electric signals from said detectors into image data.

29. An electron beam apparatus according to Claim 28, further comprising:

a first comparator for comparing images, generated by said image processing unit, of the same location of different chips on the sample;

a second comparator for comparing an image of a standard pattern for the sample with an actual image of the sample generated by said image processing unit;

a device for operating at least one of said first comparator and said second comparator; and

a device for determining defects on the sample based on at least one of results of comparisons performed by said first and second comparators.

30. An electron beam apparatus according to Claim 29, wherein said second comparator is adapted to compare an image of a particular location on the sample which is expected to suffer defects when a pattern under testing is formed on the sample with a corresponding standard pattern image, or with a pattern image for the sample which is expected to suffer less defects.

31. An electron beam apparatus according to Claim 29, wherein said second comparator is adapted to compare an image of a particular location on the sample which is expected to suffer any of a situation of a proximity effect when a pattern under testing is formed on the sample, defective stripe connection or defective field connection with a corresponding standard pattern image.

32. An electron beam apparatus according to Claim 1, further comprising:

an image acquisition device for acquiring a

plurality of images of regions under testing displaced while partially overlapping one another on the sample;

a storage device for storing reference images; and

a defect determining device for determining a defect on the sample by comparing a plurality of images of the region under testing acquired by said image acquisition device with a reference image stored in said storage device.

33. An electron beam apparatus according to Claim 1, wherein said stage apparatus comprises:

a non-contact supporting mechanism based on a hydrostatic bearing, and a vacuum sealing mechanism based on differential pumping; and

a partition positioned between a location on the sample surface irradiated with the primary electron beams and said hydrostatic bearing support of said stage apparatus, for reducing conductance,

wherein a pressure difference is produced between the electron beam irradiated region and said hydrostatic bearing support.

34. An electron beam apparatus according to Claim 33, wherein said partition contains said differential pumping structure.

35. An electron beam apparatus according to Claim 33, wherein said partition has a cold trap function.

36. An electron beam apparatus according to Claim 33, wherein two of said partitions are provided in the vicinity of an electron beam irradiated position and in the vicinity of said hydrostatic bearing.

37. An electron beam apparatus according to Claim 33, wherein said hydrostatic bearing of said stage apparatus is supplied with a gas of dry nitrogen or highly pure inert gas.

38. An electron beam apparatus according to Claim 33, wherein at least surfaces of parts of said stage apparatus facing said hydrostatic bearing are subjected to a surface treatment for reducing an emitted gas.

39. An electron beam apparatus according to Claim 1, wherein:

the sample is carried on a stage apparatus which is accommodated in a housing and supported by hydrostatic bearings with respect to said housing in a non-contact manner;

said housing for accommodating said stage apparatus is evacuated; and

said electron beam apparatus further comprises a differential pumping mechanism provided around a portion of said electron beam apparatus for irradiating the sample surface with the primary electron beams for evacuating the irradiated region on the sample surface.

40. An electron beam apparatus according to Claim 39, wherein a gas supplied to said hydrostatic bearings of said stage apparatus is dry nitrogen or highly pure inert gas, said dry nitrogen or said highly pure inert gas being exhausted from said housing for accommodating said stage apparatus, pressurized, and again supplied to said hydrostatic bearing.

41. An evaluation system for evaluating a sample, comprising:

an electron beam apparatus according to Claim 1;

a working chamber for accommodating a stage apparatus and a primary electron beam irradiating unit of said electron beam apparatus, said working chamber being controllable in a vacuum atmosphere;

a loader for supplying a sample onto said stage apparatus within said working chamber;

a potential applying mechanism disposed within said working chamber for applying the sample with a potential; and

an alignment controller for observing a surface of the sample to control alignment for positioning the sample with respect to an electro-optical system of said electron beam apparatus,

wherein said vacuum working chamber is supported through a vibration isolator for isolating vibrations from a floor.

42. An evaluation system according to Claim 42, wherein:

said loader comprises a first loading chamber and a second loading chamber which are atmospherically controllable independently of each other, a first conveyer unit for conveying a sample between the inside and the outside of said first loading chamber, and a second conveyer unit provided for said second loading chamber for conveying a sample between the inside of said first loading chamber to said stage apparatus, and

said evaluation system further comprises an mini-environment space partitioned for supplying a sample to said loader.

43. An evaluation system according to Claim 41, further comprising a laser interference measuring device for detecting coordinates of an object under testing on said stage apparatus, wherein said alignment controller determines the coordinates of the object under testing making use of a pattern which exists on the sample.

44. An evaluation system according to Claim 41, wherein positioning of the sample includes rough positioning performed in said mini-environment space, and positioning in X-Y directions and positioning in a rotating direction performed on said stage apparatus.

45. A method of manufacturing semiconductor devices, said method using an electron beam apparatus according to Claim 1 for evaluation such as a defect test for semiconductor devices in the middle of or after termination of a manufacturing process.

46. A method of manufacturing semiconductor devices, said method using an evaluation system according to Claim 41 for evaluation such as a defect test for semiconductor devices in the middle of or after termination of a manufacturing process.

47. A method of evaluating a sample, using an electron beam apparatus comprising a primary electro-optical system for irradiating said sample with primary electron beams, a detecting system for detecting an electron intensity to

output an electric signal, and a secondary electro-optical system for directing secondary electron beams generated from a surface of the sample by the irradiation of the primary electron beams thereto, wherein, a cathode of an electron gun of said primary electro-optical system includes a plurality of emitters for emitting primary electron beams, said emitters being arranged and spaced apart from each other on a circle centered at an optical axis of a primary electro-optical system, and said emitters being arranged such that when said emitters are projected onto a straight line parallel with a direction in which the primary electron beams are scanned, resulting points on the straight line are spaced at equal intervals.

48. A method of evaluating a sample according to Claim 47, wherein said emitters of said cathode of said electron gun are formed on an end surface facing the primary electro-optical system; and said electron gun further comprises a control electrode having a plurality of apertures.

49. A method of evaluating a sample according to Claim 47, further comprising the steps of:

accelerating secondary electrons emitted from the sample surface by an objective lens; and

deflecting said secondary electrons to said secondary electro-optical system by an ExB separator which comprises an electrostatic deflector having six or more electrodes, and a troidal or saddle-shaped deflector arranged outside said electrostatic deflector.

50. A method of evaluating a sample according to Claim 47, further comprising the steps of:

detecting a moving speed of a stage for carrying the sample thereon; and

calibrating the amount of deflection for at least one of the primary electron beams and the secondary electron beams in accordance with the moving speed of the stage detected at the speed detection step.

51. A method of evaluating a sample according to Claim 47, further comprising the steps of:

adjusting a beam dimension or a beam current of the primary electron beams to maximize a contrast or an S/N ratio in a particular pattern in electric signals of the secondary electron beams detected by said detectors.

52. A method of evaluating a sample according to Claim 47, further comprising the steps of:

detecting the amount of primary electron beams irradiated to the sample surface; and

controlling to prevent the amount of irradiated primary electron beam per unit area from exceeding a previously set predetermined value based on the amount of irradiation, obtained the step of detecting the irradiated amount.

53. A method of evaluating a sample according to Claim 47, further comprising the steps of:

detecting a discharge phenomenon between the sample and the objective lens or a leading phenomenon thereof; and

setting a condition for preventing a discharge based

on an output obtained at the step of detecting the discharge phenomenon.

54. A method of evaluating a sample according to Claim 47, further comprising the step of:

comparing an image of a standard pattern for the sample with an actual image of the sample generated by said electron beam apparatus, wherein an image of a particular location on the sample which is expected to suffer defects when a pattern under testing is formed on the sample with a corresponding standard pattern image, or with a pattern image for the sample which is expected to suffer less defects.

55. A method of evaluating a sample according to Claim 47, further comprising the steps of:

acquiring a plurality of images of regions under testing displaced while partially overlapping one another on the sample;

storing reference images; and

determining a defect on the sample by comparing a plurality of images of the region under testing obtained at the step of acquiring with a reference image stored at the step of string.

56. A method of evaluating a sample according to Claim 47, further comprising the steps of:

supporting a stage apparatus for carrying the sample by a hydrostatic bearing in a non-contact manner;

evacuating said stage apparatus by a differential pumping mechanism;

providing a partition positioned between a location on the sample surface irradiated with the primary electron beams and said hydrostatic bearing support of said stage apparatus, for reducing conductance, to produce a pressure difference between the electron beam irradiated region and said hydrostatic bearing support.

57. A method of evaluating a sample according to Claim 47, further comprising the steps of:

supporting a stage apparatus for carrying the sample by a hydrostatic bearing, to a housing, in a non-contact manner;

evacuating said housing containing said stage apparatus;

differential pumping an irradiation region on the sample on which the primary electron beams are radiated.